NODE=B037

$\Lambda(1405)$ $1/2^-$

$I(J^P) = 0(\frac{1}{2}^-)$ Status: ∗∗∗∗

NODE=B037

In the 1998 Note on the $\Lambda(1405)$ in PDG 98, R.H. Dalitz discussed the S-shaped cusp behavior of the intensity at the N-$\overline{K}$ threshold observed in THOMAS 73 and HEMINGWAY 85. He commented that this behavior "is characteristic of S-wave coupling; the other below threshold hyperon, the $\Sigma(1385)$, has no such threshold distortion because its N-$\overline{K}$ coupling is P-wave. For $\Lambda(1405)$ this asymmetry is the sole direct evidence that $J^P = 1/2^-$."

A recent measurement by the CLAS collaboration, MORIYA 14, definitively established the long-assumed $J^P = 1/2^-$ spin-parity assignment of the $\Lambda(1405)$. The experiment produced the $\Lambda(1405)$ spin-polarized in the photoproduction process $\gamma p \to K^+ \Lambda(1405)$ and measured the decay of the $\Lambda(1405)$(polarized) $\to \Sigma^+$(polarized)π^-. The observed isotropic decay of $\Lambda(1405)$ is consistent with spin $J = 1/2$. The polarization transfer to the Σ^+(polarized) direction revealed negative parity, and thus established $J^P = 1/2^-$.

See the related review(s):

Pole Structure of the $\Lambda(1405)$ Region

$\Lambda(1405)$ POLE POSITION

NODE=B037225

REAL PART

NODE=B037RE
NODE=B037RE

VALUE (MeV)	DOCUMENT ID		TECN
• • • We do not use the following data for averages, fits, limits, etc. • • •			
$1417.7^{+6.0}_{-7.4}{}^{+1.1}_{-1.0}$	AIKAWA	23	DPWA
1429^{+8}_{-7}	[1] MAI	15	DPWA
1434 ± 2	[2] MAI	15	DPWA
1421^{+3}_{-2}	GUO	13	DPWA
1424^{+7}_{-23}	IKEDA	12	DPWA

OCCUR=3
OCCUR=2

[1] Solution number 4.
[2] Solution number 2.

NODE=B037RE;LINKAGE=E
NODE=B037RE;LINKAGE=G

−2×IMAGINARY PART

NODE=B037IM
NODE=B037IM

VALUE (MeV)	DOCUMENT ID		TECN
• • • We do not use the following data for averages, fits, limits, etc. • • •			
$52.2^{+12.0}_{-15.8}{}^{+3.4}_{-4.0}$	AIKAWA	23	DPWA
24^{+4}_{-6}	[1] MAI	15	DPWA
20^{+4}_{-2}	[2] MAI	15	DPWA
38^{+16}_{-10}	GUO	13	DPWA
52^{+6}_{-28}	IKEDA	12	DPWA

OCCUR=3
OCCUR=2

[1] Solution number 4.
[2] Solution number 2.

NODE=B037IM;LINKAGE=E
NODE=B037IM;LINKAGE=G

$\Lambda(1405)$ MASS

NODE=B037205

PRODUCTION EXPERIMENTS

NODE=B037M1
NODE=B037M1

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
$1405.1^{+1.3}_{-1.0}$ OUR AVERAGE					
1405^{+11}_{-9}		HASSANVAND	13	SPEC	$pp \to p\Lambda(1405)K^+$
$1405^{+1.4}_{-1.0}$		ESMAILI	10	RVUE	^{4}He $K^- \to \Sigma^\pm\pi^\mp X$ at rest
1406.5 ± 4.0		[1] DALITZ	91		M-matrix fit

• • • We do not use the following data for averages, fits, limits, etc. • • •

1391 ± 1	700	[1] HEMINGWAY	85	HBC	$K^- p$ 4.2 GeV/c	
~ 1405	400	[2] THOMAS	73	HBC	$\pi^- p$ 1.69 GeV/c	
1405	120	BARBARO-...	68B	DBC	$K^- d$ 2.1–2.7 GeV/c	
1400 ± 5	67	BIRMINGHAM	66	HBC	$K^- p$ 3.5 GeV/c	
1382 ± 8		ENGLER	65	HDBC	$\pi^- p$, $\pi^+ d$ 1.68 GeV/c	
1400 ±24		MUSGRAVE	65	HBC	$\overline{p} p$ 3–4 GeV/c	
1410		ALEXANDER	62	HBC	$\pi^- p$ 2.1 GeV/c	
1405		ALSTON	62	HBC	$K^- p$ 1.2–0.5 GeV/c	
1405		ALSTON	61B	HBC	$K^- p$ 1.15 GeV/c	

[1] DALITZ 91 fits the HEMINGWAY 85 data. NODE=B037;LINKAGE=C
[2] THOMAS 73 data is fit by CHAO 73 (see next section). NODE=B037;LINKAGE=B

EXTRAPOLATIONS BELOW $N\overline{K}$ THRESHOLD

NODE=B037M2
NODE=B037M2

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1407.56 or 1407.50	[1] KIMURA	00		potential model	OCCUR=2
1411	[2] MARTIN	81		K-matrix fit	
1406	[3] CHAO	73	DPWA	0–range fit (sol. B)	
1421	MARTIN	70	RVUE	Constant K-matrix	
1416 ±4	MARTIN	69	HBC	Constant K-matrix	
1403 ±3	KIM	67	HBC	K-matrix fit	
1407.5±1.2	[4] KITTEL	66	HBC	0–effective-range fit	
1410.7±1.0	KIM	65	HBC	0–effective-range fit	
1409.6±1.7	[4] SAKITT	65	HBC	0–effective-range fit	

[1] The KIMURA 00 values are from fits A and B from a coupled-channel potential model using low-energy $\overline{K} N$ and $\Sigma \pi$ data, kaonic-hydrogen x-ray measurements, and our $\Lambda(1405)$ mass and width. The results bear mainly on the *nature* of the $\Lambda(1405)$: three-quark state or $\overline{K} N$ bound state. NODE=B037;LINKAGE=KM
[2] The MARTIN 81 fit includes the $K^{\pm} p$ forward scattering amplitudes and the dispersion relations they must satisfy. NODE=B037;LINKAGE=AA
[3] See also the accompanying paper of THOMAS 73. NODE=B037;LINKAGE=T
[4] Data of SAKITT 65 are used in the fit by KITTEL 66. NODE=B037;LINKAGE=S

$\Lambda(1405)$ WIDTH

NODE=B037210

PRODUCTION EXPERIMENTS

NODE=B037W1
NODE=B037W1

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
50.5± 2.0 OUR AVERAGE					
62 ±10		HASSANVAND	13	SPEC	$p p \to p \Lambda(1405) K^+$
50 ± 2		[1] DALITZ	91		M-matrix fit
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$24 \begin{smallmatrix} +4 \\ -3 \end{smallmatrix}$		ESMAILI	10	RVUE	^{4}He $K^- \to \Sigma^{\pm} \pi^{\mp} X$ at rest
32 ± 1	700	[1] HEMINGWAY	85	HBC	$K^- p$ 4.2 GeV/c
45 to 55	400	[2] THOMAS	73	HBC	$\pi^- p$ 1.69 GeV/c
35	120	BARBARO-...	68B	DBC	$K^- d$ 2.1–2.7 GeV/c
50 ±10	67	BIRMINGHAM	66	HBC	$K^- p$ 3.5 GeV/c
89 ±20		ENGLER	65	HDBC	
60 ±20		MUSGRAVE	65	HBC	
35 ± 5		ALEXANDER	62	HBC	
50		ALSTON	62	HBC	
20		ALSTON	61B	HBC	

[1] DALITZ 91 fits the HEMINGWAY 85 data. NODE=B037W1;LINKAGE=C
[2] THOMAS 73 data is fit by CHAO 73 (see next section). NODE=B037W1;LINKAGE=B

EXTRAPOLATIONS BELOW $N\overline{K}$ THRESHOLD

NODE=B037W2
NODE=B037W2

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
50.24 or 50.26	[1] KIMURA	00		potential model	OCCUR=2
30	[2] MARTIN	81		K-matrix fit	
55	[3,4] CHAO	73	DPWA	0–range fit (sol. B)	
20	MARTIN	70	RVUE	Constant K-matrix	
29 ±6	MARTIN	69	HBC	Constant K-matrix	
50 ±5	KIM	67	HBC	K-matrix fit	
34.1±4.1	[5] KITTEL	66	HBC		
37.0±3.2	KIM	65	HBC		
28.2±4.1	[5] SAKITT	65	HBC		

[1] The KIMURA 00 values are from fits A and B from a coupled-channel potential model using low-energy $\overline{K}N$ and $\Sigma\pi$ data, kaonic-hydrogen x-ray measurements, and our $\Lambda(1405)$ mass and width. The results bear mainly on the *nature* of the $\Lambda(1405)$: three-quark state or $\overline{K}N$ bound state. NODE=B037W2;LINKAGE=KM

[2] The MARTIN 81 fit includes the $K^{\pm}p$ forward scattering amplitudes and the dispersion relations they must satisfy. NODE=B037W2;LINKAGE=AA

[3] An asymmetric shape, with $\Gamma/2 = 41$ MeV below resonance, 14 MeV above. NODE=B037;LINKAGE=X

[4] See also the accompanying paper of THOMAS 73. NODE=B037W2;LINKAGE=T

[5] Data of SAKITT 65 are used in the fit by KITTEL 66. NODE=B037W2;LINKAGE=S

$\Lambda(1405)$ DECAY MODES

NODE=B037215;NODE=B037

	Mode	Fraction (Γ_i/Γ)	
Γ_1	$\Sigma\pi$	100 %	DESIG=1;OUR EST
Γ_2	$\Lambda\gamma$		DESIG=3
Γ_3	$\Sigma^0\gamma$		DESIG=4
Γ_4	$N\overline{K}$		DESIG=2

$\Lambda(1405)$ PARTIAL WIDTHS

NODE=B037217

$\Gamma(\Lambda\gamma)$ Γ_2

NODE=B037G1
NODE=B037G1

VALUE (keV)	*DOCUMENT ID*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •		
27±8	BURKHARDT 91	Isobar model fit

$\Gamma(\Sigma^0\gamma)$ Γ_3

NODE=B037G2
NODE=B037G2

VALUE (keV)	*DOCUMENT ID*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •		
10 ± 4 or 23 ± 7	BURKHARDT 91	Isobar model fit

$\Lambda(1405)$ BRANCHING RATIOS

NODE=B037220

$\Gamma(N\overline{K})/\Gamma(\Sigma\pi)$ Γ_4/Γ_1

NODE=B037R1
NODE=B037R1

VALUE	*CL%*	*DOCUMENT ID*	*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
<3	95	HEMINGWAY 85	HBC	$K^- p$ 4.2 GeV/c

$\Lambda(1405)$ REFERENCES

NODE=B037

AIKAWA	23	PL B837 137637	S. Aikawa *et al.*	(J-PARC E31 Collab.)	REFID=61904
MAI	15	EPJ A51 30	M. Mai, U.-G. Meissner	(BONN, JULI)	REFID=57588
MORIYA	14	PRL 112 082004	K. Moriya *et al.*	(CLAS Collab.) JP	REFID=55828
GUO	13	PR C87 035202	Z.-H. Guo, J. Oller		REFID=55110
HASSANVAND	13	PR C87 055202	M. Hassanvand *et al.*		REFID=55116
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IKEDA	12	NP A881 98	Y. Ikeda, T. Hyodo, W. Weise	(TUM, RIKEN, TINT)	REFID=54146
ESMAILI	10	PL B686 23	J. Esmaili, Y. Akaishi, T. Yamazaki	(RIKEN, ISUT+)	REFID=53294
KIMURA	00	PR C62 015206	M. Kimura *et al.*		REFID=47668
PDG	98	EPJ C3 1	C. Caso *et al.*	(PDG Collab.)	REFID=45838
BURKHARDT	91	PR C44 607	H. Burkhardt, J. Lowe	(NOTT, UNM, BIRM)	REFID=41568
DALITZ	91	JP G17 289	R.H. Dalitz, A. Deloff	(OXFTP, WINR)	REFID=41474
HEMINGWAY	85	NP B253 742	R.J. Hemingway	(CERN) J	REFID=31695
MARTIN	81	NP B179 33	A.D. Martin	(DURH)	REFID=41083
CHAO	73	NP B56 46	Y.A. Chao *et al.*	(RHEL, CMU, LOUC)	REFID=31702
THOMAS	73	NP B56 15	D.W. Thomas *et al.*	(CMU) J	REFID=31703
MARTIN	70	NP B16 479	A.D. Martin, G.G. Ross	(DURH)	REFID=31701
MARTIN	69	PR 183 1352	B.R. Martin, M. Sakitt	(LOUC, BNL)	REFID=31700
Also		PR 183 1345	B.R. Martin, M. Sakitt	(LOUC, BNL)	REFID=41082
BARBARO-...	68B	PRL 21 573	A. Barbaro-Galtieri *et al.*	(LRL, SLAC)	REFID=31693
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BIRMINGHAM	66	PR 152 1148	M. Haque *et al.*	(BIRM, GLAS, LOIC, OXF+)	REFID=31692
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ALSTON	62	CERN Conf. 311	M.H. Alston *et al.*	(LRL) I	REFID=31689
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LEINWEBER	90	ANP 198 203	D.B. Leinweber	(MCMS)	REFID=43716
MUELLER-GR...	90	NP A513 557	A. Mueller-Groeling, K. Holinde, J. Speth	(JULI)	REFID=41288
BARRETT	89	NC 102A 179	R.C. Barrett	(SURR)	REFID=41084
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WHITEHOUSE	89	PRL 63 1352	D.A. Whitehouse *et al.*	(BIRM, BOST, BRCO+)	REFID=40798
SIEGEL	88	PR C38 2221	P.B. Siegel, W. Weise	(REGE)	REFID=41089
WORKMAN	88	PR D37 3117	R.L. Workman, H.W. Fearing	(TRIU)	REFID=41088
SCHNICK	87	PRL 58 1719	J. Schnick, R.H. Landau	(ORST)	REFID=40091
CAPSTICK	86	PR D34 2809	S. Capstick, N. Isgur	(TNTO)	REFID=41090
JENNINGS	86	PL B176 229	B.K. Jennings	(TRIU)	REFID=40090
MALTMAN	86	PR D34 1372	K. Maltman, N. Isgur	(LANL, TNTO)	REFID=40088
ZHONG	86	PL B171 471	Y.S. Zhong *et al.*	(ADLD, TRIU, SURR)	REFID=40089
BURKHARDT	85	NP A440 653	H. Burkhardt, J. Lowe, A.S. Rosenthal	(NOTT+)	REFID=31707
DAREWYCH	85	PR D32 1765	J.W. Darewych, R. Koniuk, N. Isgur	(YORKC, TNTO)	REFID=31708
VEIT	85	PR D31 1033	E.A. Veit *et al.*	(TRIU, ADLD, SURR)	REFID=40100
KIANG	84	PR C30 1638	D. Kiang *et al.*	(DALH, MCMS)	REFID=31705
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BARBARO-...	72	LBL-555	A. Barbaro-Galtieri	(LBL)	REFID=31717
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